

THE GENETIC DEVELOPMENT OF THE ARTICULATION OF CONSONANT SOUNDS

A Dissertation

Submitted in Partial Fulfillment of the Requirements for
the Degree of Doctor of Philosophy

in the
University of Michigan

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Genetic Development of Articulation of Consonant Sounds in Speech

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WHAT is good speech for the kindergarten child? When is a child's speech defective? At what age should a child be given special help in articulation?

An attempt to find answers to these questions has led to the study, over a period of three years, of the ability of 140 pre-school children to articulate consonant sounds in words. The records of each child's efficiency in articulation are obtained at four month intervals by means of a simple and attractive short test consisting of isolated words evoked as responses to stimuli of objects, pictures, and questions. Results of the study present some interesting facts, given here in abstract.

Any child's ability to articulate consonant sounds in his speech is conditioned by many factors. Chronological age, intelligence, and social contacts with children of his own age have direct relation to any child's efficiency of achievement on the articulation test.

Boys and girls develop efficiency of articulation at about the same rate from $2\frac{1}{2}$ to $5\frac{1}{2}$ years of age. From this point, girls show slightly more rapid growth as indicated by zero scores on the articulation test. At $6\frac{1}{2}$ years, girls approach efficiency in articulation, while the boys require another year, until $7\frac{1}{2}$ years of age to reach the same degree of perfection.

The sounds that a child uses most in his every-day conversation are those in which he shows greatest ability in articulation. Slightly more than 64% of the sounds that appear most often in

the words of these children's conversation are articulated correctly by them before the age of $4\frac{1}{2}$. About 35% of the sounds that the child uses least often in his conversation do not develop correctly in articulation until after $5\frac{1}{2}$ years.

The twenty-three consonant sounds considered in this study are p, b, m, w, wh, v, f, t, d, n, th as in *the*, th as in *thin*, zh, sh, z, s, l, r, y, g, k, ng, and h. For most of these sounds, there is definite and regular progression toward efficiency of articulation from $2\frac{1}{2}$ to $7\frac{1}{2}$ years. For two closely related sounds, s and z, however, there is a peak of efficiency at about $4\frac{1}{2}$ years, then definite regression until about $6\frac{1}{2}$ years, when definite progress is noted again.

Different sounds are articulated correctly in the speech of all of these normal children at rather well defined limits of chronological age. At $3\frac{1}{2}$ all of the children studied are able to articulate correctly the sounds of b, p, m, w, and h. At $4\frac{1}{2}$ all of the children use consistently the sounds of d, t, n, g, k, ng, and y. At $5\frac{1}{2}$ the sound of f is well established. At $6\frac{1}{2}$ these children articulate correctly the sounds of v, th as in *the*, zh, sh, and l. Not until $7\frac{1}{2}$ are they able to articulate in their speech the sounds of z, s, r, th as in *thin*, and wh. Many individual children articulate all of the consonant sounds perfectly before these ages. The median child in the group at $6\frac{1}{2}$ articulated all of the sounds correctly. One child at three had perfect scores on the articulation tests.

That the sounds are not perfected at the same time is due to a number of

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factors, chiefly those concerned with (1) audition, (2) kinaesthetic sensory discrimination, (3) motor exercise, and (4) dentition. Any one of these factors or a combination of any or all of them, coupled with individual characteristics, operates to determine the ability of any child to use the sounds correctly in his speech.

(1) In order to produce a sound intelligently, a child must be able to hear that sound. Many speech sounds have characteristic acoustic qualities that require extreme delicacy of perception.¹ Individuals differ considerably in ability to distinguish between characteristic qualities of certain sounds. Sounds that develop early in the child's articulation are those whose characteristic acoustic qualities are determined by frequencies of vibration that are easily perceived. Many sounds that develop late have characteristic qualities that are determined by high frequencies of vibration that are difficult to perceive often by adult ears. The characteristic quality of *z*, *s*, *th* as in *thin*, and *wh*, particularly, are carried by frequencies of vibration as high as 6000 cycles per second. This frequency exceeds that of the acoustic sounds commonly used in tests of auditory perception.

(2) Before a child can establish a habit of using certain muscular adjustments of the tongue to produce certain sounds, he must have learned by some means to make that adjustment, and so accurately to perceive that this one adjustment is the correct one to produce the sound he wants that he can reproduce the adjustment at any time. The first adjustment may occur accidentally, or as a result of repeated trials, perhaps in purposeless babbling or after conscious effort. The child is guided in his attempts to repeat the sound, first by his perception of the acoustic qualities of the sound, then by kinaesthetic

sensory discrimination of the position of his tongue when he has made the sound properly. The opinion of nervous anatomists² at the present time is that there are no proprioceptive sense endings in the intrinsic muscles of the tongue; therefore kinaesthetic discrimination of the positions of the intrinsic muscles is difficult to perceive. For all of the sounds on which the tongue tip touches some other structure of the mouth, there is adequate sensory stimulus (tactile) to allow the same position to be repeated with some accuracy. For sounds in which action of the intrinsic muscles is dominant, and in which the tongue has no tactile contact, the adjustment is at best uncertain. The sounds that develop late, especially *z*, *s*, *r*, *th* as in *thin*, *l*, *sh*, *zh*, and *th* as in *the*, are produced by dominant action of the intrinsic muscles of the tongue.³ Without tactile stimuli, these muscles cannot provide accurate sensory percepts of position, and most of these late developing sounds have slight, if any, tactile contact when produced accurately.

(3) The processes of feeding provide muscular exercise for the tongue, and thus develop its ability to assume certain positions that later produce intelligible sounds.⁴ The muscle adjustments that are required to make certain of the sounds that develop very early in the child's speech, notably *b*, *p*, *m*, *w*, *d*, *t*, *n*, *g*, *k*, *ng*, and *y*, are identical with the adjustments required for feeding. Of all the sounds a child uses in his early speech, 32% are produced by the action of the tongue tip against the rugae of the palate as in suckling. These sounds are *d*, *t*, and *n*, for which the tongue position is identical, the characteristic

2 Huber, G. Carl, Director of the Anatomical Laboratories, University of Michigan, statement by private interview, March 12, 1934. Used by permission.

3 Landois, Leonard: *A Manual of Human Physiology*. Philadelphia, P. Blakiston, 1885.

Shohara, Hide: *Genesis of the Articulatory Movements of Speech*. Unpublished doctoral dissertation, University of Michigan, 1932.

Sobotta-McMurrich: *Atlas of Human Anatomy*. New York, Stechert, 1927.

4 Shohara, Hide, op. cit.

1 Fletcher, Harvey: *Speech and Hearing*. New York, Van Nostrand, 1929.

differences between them being that *d* has voice, *t* is without voice, and *n* requires that voiced breath proceed outward through the nasal cavities.

(4) Since the sides of the tongue, in producing almost all of the lingual consonants rests on the molar teeth, these teeth are probably present before the sounds can be efficiently reproduced. If they have not yet erupted, their growth within the gums has affected the shape of the palate so that adequate passage for the breath between the tongue and the palate is possible.⁵ The difficulty of articulating *s* and *z* by children 5, 6, and 7 years of age is conditioned by characteristic spacing or spreading between the anterior teeth that coincides with maturation of the dental arch. Since the accurate positions for producing *s* and *z* have been learned with difficulty on account of lack of sensory discrimination in the tongue, and since their characteristic quality is produced by diffusion of the breath stream against the rough and irregular rugae of the palate as it is blockaded by the teeth in front, any changes in the structures that effect blocking and diffusion modify the sounds produced. When the teeth very gradually spread apart and allow spaces between for air to escape, characteristic blocking cannot occur even though diffusion has been altered

but slightly or none at all.

Individual differences in ability to articulate all consonants are noted at all ages. This is due to differences in rates of maturation of the factors upon which speech development is dependent. Pathological factors that interfere with normal progress in physical growth and maturation also affect maturation of speech abilities.

The results of this study show that a normally developing child, both physically and mentally, may be expected to have reached maturity of articulation *at least* by eight years of age. Comparison with other children of his age and general abilities will show deviations in speech for any child before this age. The median girl in the groups of children studied approaches maturity of articulation shortly after six years of age, the median boy at seven. One might conclude, therefore, that unless definite pathological factors were present to alter prognosis, special help in articulation need not be given to children younger than this age. At 5½ there appears to be a sort of plateau in sound learning for slowly developing children. If, at six years, there should not be notable progress in ability to articulate all sounds, the case might well be examined by a speech clinician to determine whether special help is required to assure usual progress in ability to articulate consonant sounds.

⁵ Friel, Sheldon H.: Occlusion: Observations of its Development from Infancy to Old Age. *International Journal of Orthodontia*, 13: 322-41, 1927.

